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CULTURES OF SOME HETEROECIOUS RUSTS

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A region to the north of Pictou, Nova Scotia, offered such excellent conditions for the study of many of the rusts that have a *Peridermium* for their aecial stage, that recently some time has been spent in their field study and a few cultures have been undertaken. In this region there are extensive areas of young coniferous woods with abundant growth of *Ledum*, *Pyrola*, *Vaccinium*, *Rhododendron*, *Rubus*, *Myrica*, and *Chiogenes*, and older and more dense woods with the same species. A large area of swamp also occurs with *Chamaedaphne* and other bog plants. This region, which comprises several square miles, produced many rusts, the following, as well as a number of others, being collected: *Melampsoropsis Pyrolae*, *M. ledicola*, *M. Cassandrae*, *M. abietina*, *Pucciniastrum pustulatum*, *P. arcticum*, *P. Pyrolae*, *P. minimum*, *P. Myrtilli*, *Calyptospora columnaris*, and *Cronartium Comptoniae*. *Peridermium balsameum*, *Per. decolorans*, *Per. columnare*, *Per. Peckii*, *Per. conorum-Piceae*, *Per. consimile*, *Per. elatinum*, and *Per. abietinum* were also common.

Sowings were made on the various species of *Picea* used in the culture experiments by first placing the leaves bearing telia in a moist chamber, usually over night, until the teliospores had germinated. These leaves were then suspended over the young trees so that the basidiospores would fall on the young leaves of the spruces, and the whole was then covered with a belljar, usually for two days.

The young trees of *Picea* were obtained after the teliospores had begun to germinate in the open, but they were selected some distance from any source of infection. A considerable quantity of earth was removed with the roots and they were then placed in pots. Trees of about six to fifteen inches in height were selected, and to prevent excessive transpiration a few branches were removed. The experiments were carried on in a well-lighted

laboratory of Pictou Academy, no culture room being available. It is hoped that the experiments may be repeated and extended next spring.

The writer wishes to acknowledge with deepest gratitude invaluable suggestions and assistance rendered by Dr. J. C. Arthur, without which the cultures would probably not have been undertaken. The writer's thanks are also due to Mr. John Macoun, of the Geological Survey of Canada, for determining some of the host plants.

MELAMPOROPSIS CASSANDRAE (Peck & Clinton) Arthur

The uredinial stage of this rust was collected on *Chamaedaphne calyculata* (L.) Moench in a large swamp during the summer of 1909. The host plants were kept under observation during the next spring for the purpose of collecting the telial stage. It was found in June in several places in the swamp and always on plants growing beside *Picea*. The teliospores were first noticed germinating on June 13 and they continued to germinate for some time in moist weather. Leaves bearing mature telia were collected and sowings were made on young trees of *Picea rubra* (DuRoi) Dietr. on June 17. Pycnia appeared on June 29, followed by aecia in a short time. Four plants were used and each sowing was successful. The infection was marked, and was most abundant just below where the telia-bearing leaves had been suspended. Two trees obtained in the same place as those used in the experiment were kept as controls and they remained free from aecia. The aecia were found on examination to be *Peridermium consimile* Arth. & Kern.

The spruces in the swamp near which the telia were found were watched for the appearance of aecia. Both pycnia and aecia developed abundantly and in such a position as to leave little doubt that the infection came from the telia on *Chamaedaphne*. Collections were made on July 17 and 24. On the latter date the aecia were mature. Part of the collection of July 17 was sent to Dr. Arthur for determination. He replied that it was *Peridermium consimile* Arth. & Kern and the host *Picea rubra* (DuRoi) Dietr.

Clinton (Rep. Conn. Agric. Exper. Sta. 6: 386. 1908) sowed

the spores of *Peridermium consimile* on *Chamaedaphne calyculata* and the uredinial stage of *Melampsoropsis Cassandrae* appeared. This seems to be the only previous attempt to establish the connection of these forms.

MELAMPSOROPSIS ABIETINA (Alb. & Schw.) Arthur

The uredinial stage of this rust was very common on *Ledum groenlandicum* Oeder in the summer of 1909, and many collections of aecia were made on the spruces near, which seemed to belong to the form on *Ledum*, but as no telia were collected the connection appeared doubtful. The next spring telia were found to be very common on the under side of small, thin leaves of *Ledum*, from which the tomentum was absent. The teliospores were germinating freely the second week of June, the first collection being on June 10. At this time the young shoots of *Picea rubra* and *P. mariana* were opening, those of *P. canadensis* having opened about a week earlier.

On June 16 sowings were made on *Picea rubra* (DuRoi) Dietr. Pycnia appeared abundantly on June 25 and abundant aecia soon followed. Four trees were used and the infection was pronounced on all of them. The aecia were found on examination to be *Peridermium abietinum* (Alb. & Schw.) Thüm. Two plants of *Picea* obtained in the same place as those used for the cultures were kept as controls and remained free from aecia.

In the field, pycnia and aecia developed on the spruces that grew near the telia-bearing *Ledum*. This was observed in many places, though sometimes *M. ledicola* was near and a possible source of infection. In one place where there was abundant germination of the telia of *M. abietina* and no other rust was in the vicinity, the aecial infection on the spruces near was very pronounced. A collection from this source was made on July 17 and part of it was sent to Dr. Arthur. He reported the collection as *Peridermium abietinum* (Alb. & Schw.) Thüm. and the host as *Picea rubra* (DuRoi) Dietr.

All the forms of this rust are very common in the vicinity of Pictou. The telial stage was often found occurring on the same plants as *M. ledicola*, but was much more common than that species.

MELAMPSOROPSIS LEDICOLA (Peck) Arthur

Peridermium decolorans Peck was found to be very common on *Picea*, especially on *Picea canadensis* (Mill.) BSP., during the summer of 1909. In the spring of the following year the *Ledum* plants that were near the trees so richly infected by *Per. decolorans* were kept under observation and telia were found germinating about the first of June. The telia were then quite conspicuous on the upper surface of the leaves.

On June 7 sowings were made on four young trees of *Picea canadensis*. Pycnia were evident on June 19 and aecia followed in a short time. All the plants developed pycnia and aecia, but the infection was sparing on two of them and pronounced on the others. The aecia were determined as *Peridermium decolorans* Peck. Two plants of *Picea canadensis* from the same place as those used in the cultures were kept as controls and remained free from aecia.

The young shoots of *Picea canadensis* were just opening as the telia of *M. ledicola* began to germinate in the field and not until a week or ten days later did the buds of *P. rubra* and *P. mariana* open. This may account for the *Peridermium* being much more common on *Picea canadensis* than on the other species.

The trees of *Picea canadensis* that grew beside the rusted *Ledum* developed pycnia and aecia very abundantly; the trees nearest showed the richest infection, the aecia gradually diminishing as the trees became more distant from the *Ledum* rust. A collection of the aecia was sent to Dr. Arthur, and was determined as *Peridermium decolorans* Peck. During the summer several collections of *P. decolorans* were made, and in every case *Ledum* plants were found near, the leaves of which showed the spots where the telia of *M. ledicola* had germinated in the spring.

The aecia on *P. canadensis* were shedding spores by July 5. A few collections of aecia were made on *P. mariana* during the summer.

MELAMPSOROPSIS PYROLAE (DC.) Arthur

Rostrup has suggested that *Peridermium conorum-Piceae* (Reess) Arth. & Kern is the aecial stage of this rust. Arthur and Kern (Bull. Torrey Club 33: 432. 1906) state that the

geographical distribution of the form on *Pyrola* would favor this assumption. As the uredinial and telial stages were very common on *Pyrola americana* Sweet and *P. elliptica* Nutt., their development was watched during the spring and early summer of last year, and the cones of the spruces in the vicinity were also kept under observation for evidence bearing on these suggestions.

By May 7 many of the uredinia were mature and the spores were escaping. The telia were first noticed germinating on May 20, and by May 23 germination was general. At this time the young pistillate cones of *Picea canadensis* were open and in a few days those of *P. rubra* and *P. mariana* were in the same condition. By the first of June the teliospores had pretty well germinated and no germinating material could be found on June 10. The cones of the spruces in the vicinity were closely watched for the appearance of pycnia. Their first appearance, as indicated by the yellow color of the scales, was on June 21, and by July 4 they were common. Owing to my absence, the place could not be visited again until July 17, when it was found that the aeciospores of *Peridermium conorum-Piceae* were being shed very abundantly from the cones of *Picea mariana* in the vicinity of the rusted *Pyrola* plants. The cones of the young trees that were easily accessible were found to be generally infected, and many of the cones on the larger trees were also infected. The *Peridermium* is conspicuous at this time, and the aecia-bearing cones could be seen at a considerable distance. As far as was observed the *Peridermium* was confined to the vicinity of the *Pyrola* plants that bore germinating telia in the spring.

The field evidence strongly supported the view that these forms are connected, and tends to confirm the statement of Arthur and Kern (l. c.) that the *Peridermium* is common though not often collected.

CALYPTOSPORA COLUMNARIS (Alb. & Schw.) Kuehn

A collection of the aecial stage of this rust was reported from Pictou last year (Science 30: 814. 1909). It was then found to be generally distributed but rather sparingly developed in any place. Observations were begun earlier in the spring of 1910 and well developed aecia were collected on June 21. The aecia

soon became common, and in shaded places where the form on *Vaccinium* was near, were abundant and rather conspicuous on the young host plants, *Abies balsamea* (L.) Mill. It would seem that the collections of last year were made after the period of greatest abundance was past. Collections were made at other places in the province, and the aecial stage is probably common everywhere.

PERIDERMIIUM BALSAMEUM Peck

This form is very common on its host throughout this province. It was found so often associated with *Pucciniastrum arcticum* (Lagerh.) Tranz. on *Rubus idaeus* var. *aculeatissimus* (C. A. Mey.) Regel & Tiling, that it pointed strongly to their connection. *Pucciniastrum pustulatum* and *P. minimum* are also common but there was no evidence of their connection with the *Peridermium*.

UROMYCES PECKIANUS Farlow

This rust was found common on *Distichlis spicata* (L.) Greene around the border of a small inlet of the harbor. Aecia were collected in several places in May on *Atriplex patula* L. and in each case the telia of *Uromyces Peckianus* were found close beside the infected plants. The aecia were very abundant, and examination showed that the teliospores of the *Uromyces* had germinated. The evidence of connection was so strong that it was decided to try a culture. Telial material had been collected from the same place in the spring and was available for use. This material was placed in a moist chamber and gave excellent germination. Plants of *Atriplex* were obtained at the seashore, as far removed as possible from the rusted *Distichlis*, and were placed in pots. Telial material was placed in a moist chamber over night when it was found to be germinating. The teliospores were then transferred with a knife to the leaves of the *Atriplex*, and the plants were covered with a belljar for a day or two. The sowing was made on May 21. Pycnia were noticed on the plants in one of the pots on June 4, but they probably appeared earlier. Aecia developed in a short time. The infection was rather sparing, only about half a dozen spots with aecia appearing altogether. The second pot of plants showed no infec-

tion, but the plants did not flourish. A pot of *Atriplex* obtained at the same place as the others was kept as a control; it remained free from aecia.

A number of plants of *Atriplex* had also been transferred to the garden outside. A sowing was made on these by germinating the teliospores in a moist chamber, and suspending the *Distichlis* leaves bearing them so that the basidiospores would fall on the *Atriplex* plants; the whole was then covered with a belljar for about two days. This sowing was made on May 28 and on June 11 abundant pycnia were noticed, which probably appeared before that date, as the plants were not carefully watched. Aecia began to form in abundance but they were eaten out of the leaves, probably by insect larvae or slugs. The experiment was carried on outside.

The infection was so marked that it left little doubt that the forms were connected, and to establish this another experiment was tried in the laboratory. Plants of *Atriplex* were obtained as before; also a number of flourishing young plants of *Chenopodium album* L. from a waste heap. Sowings were made on these on June 12 by suspending above them *Distichlis* leaves bearing telia that had been germinated in a moist chamber. The whole was then covered as usual with a belljar for a day or two. The plants were carefully watched and pycnia became evident on June 21 and were soon followed by abundant aecia. The infection was very marked on both the *Atriplex* and *Chenopodium*, but especially so on the latter, where the aecia frequently formed rows on the leaves corresponding to the *Distichlis* that had been suspended above. No aecia developed on the plants in the field around those that had been used for the experiments, and controls of *Atriplex* remained free from infection. Some of the *Atriplex* plants used in the experiments were matured and were found to be *Atriplex patula* var. *hastata* (L.) Gray.

Collections of aecia were made on *Salicornia europea* L. and *Suaeda maritima* (L.) Dumort, which, from their association with the telia on *Distichlis*, seemed to be also connected. A sowing was tried on *Salicornia*, but without result. The plants, however, did not flourish and it may have been on that account that there

was no infection. The field evidence went to show that *Salicornia*, if connected, was not readily infected.

Arthur has shown by numerous experiments that *Puccinia subnitens* Diet., also on *Distichlis spicata*, has its aecia on *Chenopodium* and *Atriplex* as well as on a number of other plants. These experiments show that *Uromyces Peckianus* has similar aecial hosts.

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